

In-Situ Deposition Of YBCO High-Tc Superconducting Thin Films By MOCVD and PE-MOCVD

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Metalorganic Chemical Vapor Deposition (MOCVD) offers the advantages of a high degree of compositional control, adaptability for large scale production, and the potential for low temperature fabrication. The capability of operating at high oxygen partial pressure is particularly suitable for in-situ formation of HTSC films. YBCO thin films having a sharp zero-resistance transition with $T_c > 90\text{K}$ and $J_c \sim 10^4 \text{A}$ on YSZ have been prepared, in-situ, at a substrate temperature of about 800°C . Moreover, the ability to form oxide films at low temperature is very desirable for device applications of HTSC materials. Such a process would permit the deposition of high quality HTSC films with a smooth surface on a variety of substrates. Highly c-axis oriented, dense, scratch resistant, superconducting YBCO thin films with mirror-like surfaces have been prepared, in-situ, at a reduced substrate temperature as low as 570°C by a remote microwave-plasma enhanced metalorganic chemical vapor deposition (PE-MOCVD) process. Nitrous oxide was used as a reactant gas to generate active oxidizing species. This process, for the first time, allows the formation of YBCO thin films with the orthorhombic superconducting phase in the as-deposited state, as shown in Fig.1 by the filled circle. Fig.1 plots oxygen partial pressure vs. temperature showing the phase transition lines of $\text{YBa}_2\text{Cu}_3\text{O}_{7-y}$ and parameters from the literature for successful in-situ growth.¹ The as-deposited films grown by PE-MOCVD show attainment of zero resistance at 72K with a transition width of about 5K . MOCVD was carried out in a commercial production scale reactor with the capability of uniform deposition over 100cm^2 per growth run. Our preliminary results indicate that PE-MOCVD is a very attractive thin film deposition process for superconducting device technology.

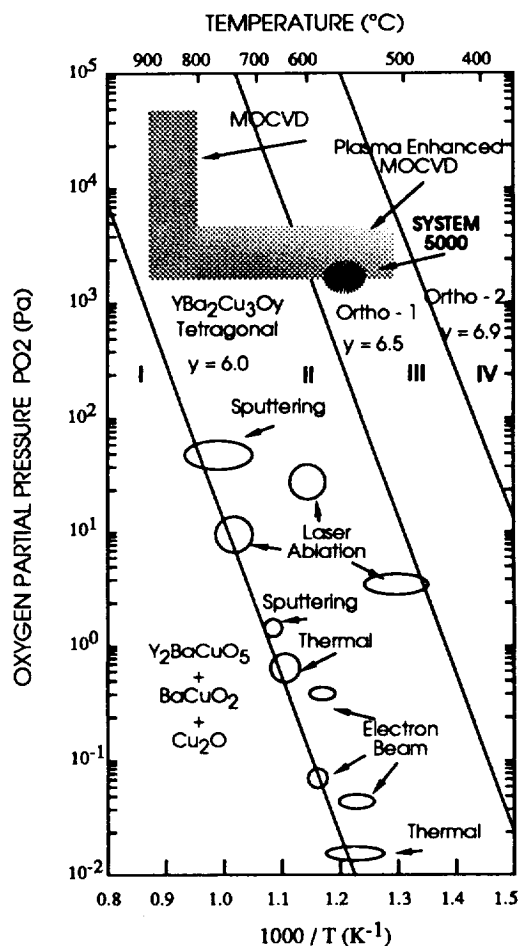


Fig.1. Oxygen partial pressure vs. temperature plot showing the critical stability line for YBCO at $y = 6.0$ together with parameters from the literature for successful in-situ growth. In addition, the tetragonal-orthorhombic transition line at $y = 6.5$ and the stability line for $y = 6.9$ are given.

¹ R.H. Hammond and R. Bormann, International Conference of High-Temperature Superconductors, 1989.